

AMENDMENTS TO THE CLAIMS

Listing of the claims

Following is a listing of all claims in the present application, which listing supersedes all previously presented claims:

1. (Currently Amended) A system for detecting malfunction of an engine cooling apparatus constituted as a radiator having an inlet pipe and an outlet pipe each connected to an internal combustion engine in such a manner that coolant flows in the radiator through the inlet pipe to be cooled and is then recirculated back to the engine through the outlet pipe, and a thermostat opening/closing the inlet pipe and the outlet pipe, comprising:

a temperature sensor installed at the radiator and detecting a temperature of the coolant flowing through at least one of the inlet pipe and outlet pipe;

malfunction discrimination area determining means for determining whether operation of the engine since starting is within an area that enables malfunction discrimination of the cooling apparatus; and

malfunction discriminating means for discriminating whether the cooling apparatus has malfunctioned based on change of the temperature of the coolant measured by said temperature sensor since the engine starting, when the operation of the engine is discriminated to be within the malfunction discrimination area,

wherein the malfunction discrimination area determining means includes:

time measuring means for measuring a period of time since the engine starting;

and

time comparing means for comparing the measured period of time with a predetermined period of time calculated based on at least the temperature of the coolant at engine starting, a load of the engine, and a speed of a vehicle on which the engine is mounted;

and determines that the operation of the engine is within the malfunction discrimination area when the measured period of time exceeds the predetermined period of time.

2. (Canceled)

3. (Currently Amended) A system according to claim 1 2, wherein malfunction discriminating means includes:

temperature comparing means for comparing the temperature of the coolant with a reference value;

and discriminates that the cooling apparatus has malfunctioned, when the temperature of the coolant exceeds the reference value.

4. (Currently Amended) A system according to claim 1 2, wherein the predetermined period of time is further calculated based on ~~from~~ at least one of ~~a load of the engine, a speed of vehicle on which the engine is mounted, the temperature of the coolant at engine starting,~~ an operating condition of a heater of a compartment of the vehicle and an operating condition of an air conditioner of the compartment of the vehicle.

5. (Original) A system according to claim 3, wherein the reference value is calculated from at least one of a load of the engine, a speed of vehicle on which the engine is mounted, the temperature of the coolant at engine starting, operating condition of a heater of a compartment of the vehicle and operating condition of an air conditioner of the compartment of the vehicle.

6. (Previously Presented) A system for detecting malfunction of an engine cooling apparatus constituted as a radiator having an inlet pipe and an outlet pipe each connected to an internal combustion engine in such a manner that coolant flows in the radiator through the inlet pipe to be cooled and is then recirculated back to the engine through the outlet pipe, and a thermostat opening/closing the inlet pipe and the outlet pipe, comprising:

a temperature sensor installed at the radiator and detecting a temperature of the coolant flowing through at least one of the inlet pipe and outlet pipe;

malfunction discrimination area determining means for determining whether operation of the engine since starting is within an area that enables malfunction discrimination of the cooling apparatus; and

malfunction discriminating means for discriminating whether the cooling apparatus has malfunctioned based on change of the temperature of the coolant since the engine starting, when the operation of the engine is discriminated to be within the malfunction discrimination area,

wherein the malfunction discrimination area determining means includes:

time measuring means for measuring a period of time since the engine starting;
and

time comparing means for comparing the measured period of time with a predetermined period of time;

and the operation of the engine is within the area that enables the malfunction discrimination of the cooling apparatus, when the measured period of time exceeds the predetermined period of time, and

wherein malfunction discriminating means includes:

temperature comparing means for comparing the temperature of the coolant with a reference value;

and discriminates that the cooling apparatus has malfunctioned, when the temperature of the coolant exceeds the reference value, and

wherein the temperature comparing means compares the temperature of the coolant with the reference value and an additional reference value;

and discriminates that the cooling apparatus has malfunctioned, if the temperature of the coolant exceeds a highest one of the reference values, even when the measured period of time does not exceed the predetermined period of time.

7. (Previously Presented) A system for detecting malfunction of an engine cooling apparatus constituted as a radiator having an inlet pipe and an outlet pipe each connected to an internal combustion engine in such a manner that coolant flows in the radiator through the inlet pipe to be cooled and is then recirculated back to the engine

through the outlet pipe, and a thermostat opening/closing the inlet pipe and the outlet pipe, comprising:

a temperature sensor installed at the radiator and detecting a temperature of the coolant flowing through at least one of the inlet pipe and outlet pipe;

malfunction discrimination area determining means for determining whether operation of the engine since starting is within an area that enables malfunction discrimination of the cooling apparatus; and

malfunction discriminating means for discriminating whether the cooling apparatus has malfunctioned based on change of the temperature of the coolant since the engine starting, when the operation of the engine is discriminated to be within the malfunction discrimination area,

wherein the malfunction discrimination area determining means includes:

time measuring means for measuring a period of time since the engine starting;
and

time comparing means for comparing the measured period of time with a predetermined period of time;

and the operation of the engine is within the area that enables the malfunction discrimination of the cooling apparatus, when the measured period of time exceeds the predetermined period of time, and

wherein malfunction discriminating means includes:

temperature comparing means for comparing the temperature of the coolant with a reference value;

and discriminates that the cooling apparatus has malfunctioned, when the temperature of the coolant exceeds the reference value, and

wherein the temperature comparing means compares the temperature of the coolant with the reference value and additional reference values;

and reserves discrimination that the cooling apparatus has malfunctioned, if the temperature of the coolant exceeds a lowest one of the reference values, but the temperature of the coolant does not exceed one of the reference values that is higher than the lower one.

8. (Previously Presented) A system for detecting malfunction of an engine cooling apparatus constituted as a radiator having an inlet pipe and an outlet pipe each connected to an internal combustion engine in such a manner that coolant flows in the radiator through the inlet pipe to be cooled and is then recirculated back to the engine through the outlet pipe, and a thermostat opening/closing the inlet pipe and the outlet pipe, comprising:

a temperature sensor installed at the radiator and detecting a temperature of the coolant flowing through at least one of the inlet pipe and outlet pipe;

malfunction discrimination area determining means for determining whether operation of the engine since starting is within an area that enables malfunction discrimination of the cooling apparatus; and

malfunction discriminating means for discriminating whether the cooling apparatus has malfunctioned based on change of the temperature of the coolant since

the engine starting, when the operation of the engine is discriminated to be within the malfunction discrimination area,

wherein the malfunction discrimination area determining means includes:

time measuring means for measuring a period of time since the engine starting;

and

time comparing means for comparing the measured period of time with a predetermined period of time;

and the operation of the engine is within the area that enables the malfunction discrimination of the cooling apparatus, when the measured period of time exceeds the predetermined period of time, and

wherein malfunction discriminating means includes:

temperature comparing means for comparing the temperature of the coolant with a reference value;

and discriminates that the cooling apparatus has malfunctioned, when the temperature of the coolant exceeds the reference value, and

wherein the temperature comparing means compares the temperature of the coolant with the reference value and additional reference values;

and discriminates that the cooling apparatus is normal, if the temperature of the coolant does not exceed a lowest one of the reference values.

9. (Original) A system according to claim 1, wherein the malfunction discriminating means discriminates that the thermostat has experienced open-state sticking such that the cooling apparatus has malfunctioned.

10. (Currently Amended) A system for detecting malfunction of an engine cooling apparatus constituted as a radiator having an inlet pipe and an outlet pipe each connected to an internal combustion engine in such a manner that coolant flows in the radiator through the inlet pipe to be cooled and is then recirculated back to the engine through the outlet pipe, and a thermostat opening/closing the inlet pipe and the outlet pipe, comprising:

a temperature sensor installed at the radiator and detecting a temperature of the coolant flowing through at least one of the inlet pipe and outlet pipe;

time measuring means for measuring a period of time since the engine starting;

time comparing means for comparing the measured period of time with a predetermined value indicative of a period of time until the thermostat presumably opens after the engine starting calculated based on at least the temperature of the coolant at engine starting, a load of the engine, and a speed of a vehicle on which the engine is mounted;

temperature comparing means for comparing the temperature of the coolant measured by said temperature sensor with a reference value, when the measured period of time exceeds the predetermined value; and

malfunction discriminating means for discriminating that the cooling apparatus has malfunctioned, when the temperature of the coolant measured by said temperature sensor exceeds the reference value.

11. (Previously Presented) A system for detecting malfunction of an engine cooling apparatus constituted as a radiator having an inlet pipe and an outlet pipe each

connected to an internal combustion engine in such a manner that coolant flows in the radiator through the inlet pipe to be cooled and is then recirculated back to the engine through the outlet pipe, and a thermostat opening/closing the inlet pipe and the outlet pipe, comprising:

a temperature sensor installed at the radiator and detecting a temperature of the coolant flowing through at least one of the inlet pipe and outlet pipe;

time measuring means for measuring a period of time since the engine starting;

time comparing means for comparing the measured period of time with a predetermined value indicative of a period of time until the thermostat presumably opens after the engine starting;

temperature comparing means for comparing the temperature of the coolant with a reference value, when the measured period of time exceeds the predetermined value;
and

malfunction discriminating means for discriminating that the cooling apparatus has malfunctioned, when the temperature of the coolant exceeds the reference value,

wherein the temperature comparing means compares the temperature of the coolant with the reference value and additional reference values;

and the malfunction discriminating means discriminates that the cooling apparatus has malfunctioned, if the temperature of the coolant exceeds a highest one of the reference values, even when the measured period of time does not exceed the predetermined value.

12. (Previously Presented) A system for detecting malfunction of an engine cooling apparatus constituted as a radiator having an inlet pipe and an outlet pipe each connected to an internal combustion engine in such a manner that coolant flows in the radiator through the inlet pipe to be cooled and is then recirculated back to the engine through the outlet pipe, and a thermostat opening/closing the inlet pipe and the outlet pipe, comprising:

a temperature sensor installed at the radiator and detecting a temperature of the coolant flowing through at least one of the inlet pipe and outlet pipe;

time measuring means for measuring a period of time since the engine starting;

time comparing means for comparing the measured period of time with a predetermined value indicative of a period of time until the thermostat presumably opens after the engine starting;

temperature comparing means for comparing the temperature of the coolant with a reference value, when the measured period of time exceeds the predetermined value; and

malfunction discriminating means for discriminating that the cooling apparatus has malfunctioned, when the temperature of the coolant exceeds the reference value,

wherein the temperature comparing means compares the temperature of the coolant with the reference value and additional reference values;

and the malfunction discriminating means reserves discrimination that the cooling apparatus has malfunctioned, if the temperature of the coolant exceeds a lowest one of the reference values, but the temperature of the coolant does not exceed one of the reference values that is higher than the lowest one.

13. (Original) A system according to claim 12, wherein the temperature comparing means compares the temperature of the coolant with the reference value and additional reference values;

and the malfunction discriminating means discriminates that the cooling apparatus is normal, if the temperature of the coolant does not exceed the lowest one of the reference values.

14. (Original) A system according to claim 10, wherein the malfunction discriminating means discriminates that the thermostat has experienced open-state sticking such that the cooling apparatus has malfunctioned.